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APPLICATION NUMBER: ***60/521,381***
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Electronic Version v11

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Title of Invention	HARROW FRAME AND HARROW FORMED THEREWITH

As the below named inventor, I declare that:

This declaration is directed to the invention titled: " HARROW FRAME AND HARROW FORMED THEREWITH"

I believe that I am the original and first inventor of the subject matter which is claimed and for which a patent is sought;

I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

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All statements made herein of my knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR:

Inventor: Brian J. Read	Inventor
Signature :	Citizen of : CA

APPLICATION DATA SHEET

Electronic Version v14

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Title of Invention	HARROW FRAME AND HARROW FORMED THEREWITH

Application Type : provisional, utility

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Title of Invention	HARROW FRAME AND HARROW FORMED THEREWITH

Application Number :

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First Named Applicant: Brian J. Read

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Submitted By:	Elec. Sign.	Sign. Capacity
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Documents being submitted:	Files
us-fee-sheet	30464-20-usfees.xml
	us-fee-sheet.xsl
	us-fee-sheet.dtd
us-declaration	30464-20-usdecl.xml
	us-declaration.dtd
	us-declaration.xsl
us-request	30464-20-usrequ.xml
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Description

HARROW FRAME AND HARROW FORMED THEREWITH

BACKGROUND OF INVENTION

[0001] The invention relates to harrow and in particular a harrow and a harrow frame therefore.

[0002] Harrows are used in agricultural applications to work by loosening and aerating the soil. A harrow is towed through the field and includes a frame, generally conveyed on wheels, and ground working tools mounted on the frame.

[0003] It is desirable that the field be worked in as few passes as possible. Thus it is desirable that the harrow be as wide as structurally possible. However, this poses a problem in shipping the harrow and moving the harrow from field to field. In particular, many transport regulations require a permit in order to transport vehicle or load which is more than 10 feet and often more than 81/2 feet wide. While many harrows can be folded, they often do not meet the

non-permit width requirements.

[0004] A harrow is useful when it can be used for aggressively working the soil in a field to be planted as well as for lightly disturbing the soil to uproot weeds in a field that has already been planted. The degree to which the soil is worked by the harrow is determined by the angle, termed angle of aggression, at which the harrow is passed over the field. It is desirable that the harrow has a variable angle of aggression for versatility. While some harrows are available with variable aggression angles, the adjustment of the angle of aggression is complex and requires stopping the harrow and making several manual adjustments. In particular, with reference to Figure 1, a prior art harrow is shown which includes a frame having a left tool support arm 2a and a right tool support arm 2b that each support a harrow ground working tool 3, such as a rotary spike harrow. The arms 2a, 2b extend outwardly from a drive carriage 4 that rides along a center beam 1 of the frame. During use, the arms are held out at a selected angle from drive carriage 4 by locking the drive carriage at a selected position along the center beam and by adjustment of stabilizer beams 6 and tension chains 7. The stabilizer beams support arms 2a, 2b from behind and the tension

chains prevent the arms from folding away from the hitch until the chains are released. Arms 2a, 2b can be repositioned to have a selected angle of aggression or folded back away from the hitch by unlocking the drive carriage from the center beam and moving it along the center beam by adjusting the angle between the stabilizer beams by use of hydraulic cylinders 9 and by adjusting each tension chain 7 length by releasing them or by working a winch. As will be appreciated, arm repositioning requires much manual adjustment and coordination between hydraulic cylinders 9 themselves and between the cylinders and the chains.

[0005] When attempting to fold the harrow, the tension in chains 7 is released and stabilizer beams 6 are driven together above center beam 1, which drives carriage 4 forwardly along the center beam. This pulls supports arms 2a and 2b back toward tail harrow 8. The folding is hindered by the presence the tail harrow 8, the wheels supporting the center beam and the ground working tools. This prevents the harrow from being folded to anything less than about 13 feet.

SUMMARY OF INVENTION

[0006] A harrow frame has been invented that facilitates selection

and adjustment of an angle of aggression. The harrow angle of aggression may be adjusted "on-the-fly", while the harrow is being moved along the ground, for example during ground treatment therewith or while the harrow is being moved to, from or between fields. In another embodiment, the frame may be folded for transport. The frame may also include one or more other features that facilitate use of the harrow.

[0007] In accordance with a broad aspect of the present invention, there is provided a harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a towing end, a center unit, a right tool support arm being elongate and having a secured end and an outboard end, a left tool support arm being elongate and having a secured end and an outboard end, the left tool support arm and the right tool support arm each acting as levers each with a fulcrum on their secured ends through which they engage the center unit, a drive system acting adjacent the secured ends of the tool support arms to pivot the left tool support arm and the right tool support arm about their fulcrums to move them between a first relative angle and a second relative angle and a lock to releasably lock the left tool support arm and the right tool support

arm into the first relative angle and the second relative angle, the drive and the lock being controllable remotely such that the left tool support arm and the right tool support arm can be pivoted about their fulcrums while the harrow frame is being moved along a ground surface.

[0008] The harrow frame tool support arms may be locked and driven substantially exclusively through connections at their secured ends. In one embodiment, those connections may be provided between their secured ends and their fulcrums. In one embodiment, the lock and/or the drive system may be selected to act without relying on the use of support beams or tension chains connected to the tool support arms between the fulcrum and the outboard end.

[0009] In one embodiment, the first relative angle may be a first selected angle of aggression and the second relative angle may be a second selected angle of aggression. In another embodiment, the first relative angle may be an open position for use and the second relative angle may be a folded position. In the folded position, the relative angle between the left tool support arm and the right tool support arm may be such that the width defined between the outer limits of the left tool support arm and the right tool sup-

port arm may be less than 8.5 feet.

[0010] The drive system may be a means such as a screw drive or a hydraulic cylinder that may be connected at one drive point to both the left tool support arm and the right tool support arm such that any input drive of the drive system may be conveyed to the tool support arms substantially simultaneously. In one embodiment, the lock may be incorporated into the drive system, as by use of a locking hydraulic cylinder.

[0011] In accordance with another broad aspect of the present invention, there is provided a harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a towing end, a center unit, a right tool support arm being elongate and having a secured end and an outboard end, a left tool support arm being elongate and having a secured end and an outboard end, the left tool support and the right tool support arm each acting as levers each with a fulcrum on their secured ends through which they engage the center unit, a drive system acting adjacent the secured ends of the tool support arms to pivot the left tool support arm and the right tool support arm substantially simultaneously about their fulcrums to move them between a folded condition and an open position for use

and a lock to releasably lock the left tool support arm and the right tool support arm into the open position for use, the drive system, the lock and the fulcrums selected such that in the folded condition, the frame has a width of less than 8.5 feet.

[0012] The drive system may be a means such as a screw drive or a hydraulic cylinder that may be connected at one drive point to both the left tool support arm and the right tool support arm such that any input drive of the drive system may be conveyed to the tool support arms substantially simultaneously. To reduce the folded size of the frame, the drive system can be positioned such that it may be substantially outside of the area between the folded tool support arms. In one embodiment, the drive system may be positioned between the towing end and the center unit and the tool support arms fold away from the towing end behind the center unit.

[0013] In one embodiment, the lock acts adjacent the secured end to lock the left tool support arm and the right tool support arm into the open position for use. In one embodiment, the lock may be incorporated into the drive system, as by use of a locking hydraulic cylinder.

[0014] Wheels can be provided in any configuration to support

the frame such that it can be pulled over a field to be worked or for transport when not in use. In one embodiment, there may be at least one wheel positioned to support the center unit and at least one wheel to support the outboard end of each tool support arm. To facilitate operation, a wheel supporting the center unit may be fixed substantially against pivoting about a vertical axis and wheels supporting the tool support arms are caster style wheels capable of pivoting about a substantially vertical axis.

[0015] In one embodiment, the harrow frame includes a trailing unit for supporting a tail harrow ground working portion, the trailing unit having an outboard end and a secured end. In one embodiment, the harrow frame includes a lift mechanism to raise the outboard end of the trailing unit upwardly during a folding operation to permit the left tool support arm and the right tool support arm to be folded together and positioned under the trailing unit. The harrow frame can include a safety lock selected to prevent the left and right tool support arms from being moved into the folded configuration without the trailing unit first being raised upwardly. In another embodiment, there may be provided a safety lock to prevent the support arms

from unfolding inadvertently. For example, the trailing unit can include a safety lock, which may be selected to lock the right tool support arm and the left tool support arm together in the folded configuration by setting the trailing unit down on the tool support arms when they are folded together.

[0016] In accordance with another broad aspect of the present invention, there may be provided a harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a hitch, a center unit, a right elongate tool support arm having a secured end and an outboard end, a left elongate tool support arm having a secured end and an outboard end, the left tool support and the right tool support arm each including a first bracket and a second bracket spaced apart on the tool support arm for engaging the ends of a ground working tool to be mounted on the frame, the first bracket including an end connected to the tool support arm, a connector end for engaging the ground working portion and a pivotal connection between the tool support arm and the connector end selected to permit the connector end to pivot relative to the end secured to the tool support arm and independently of the second bracket.

Brief Description of Drawings

[0017] Figure 1 is a perspective view of a prior art harrow.

[0018] Figure 2 is a top plan view of a harrow frame.

[0019] Figure 3A, 3B and 3C are top plan views of a harrow in 25° angle of aggression, 45° angle of aggression and folded configurations, respectively.

[0020] Figures 4A, 4B and 4C are enlarged top plan views of the drive system in the 25° angle of aggression, 45° angle of aggression and folded configurations, respectively.

[0021] Figure 5A is a top plan view of a drive system useful in the present invention.

[0022] Figure 5B is a side view of a center unit and trailing unit useful in the present invention.

[0023] Figure 6 is a front elevation of a tail harrow bracket useful in the present invention.

[0024] Figure 7 is an enlarged view of a ground working portion bracket useful in the present invention.

[0025] Figure 8A is a top plan view of a harrow frame according to the present invention.

[0026] Figures 8B to 8F are enlarged top plan views of various configurations of a drive system useful in the harrow frame of Figure 8A.

DETAILED DESCRIPTION

[0027] Referring to Figure 2 there is shown one embodiment of a harrow frame 10 that may include a hitch 12, a center unit 14, a right tool support arm 16, a left tool support arm 18, a trailing unit 20, a drive system 22 for driving the tool support arms into various relative angles and a plurality of wheels 24, 26, 28 for supporting the frame during transport.

[0028] The harrow frame, when in use, may have mounted thereon ground working tools 27, 33, as shown in Figures 3, and is pulled about a field to work the soil therein. Thus, the frame may be suitable for towing by a vehicle such as a truck or tractor by connection through hitch 12 or by other means. The frame may be formed to withstand the stresses placed thereon. In the illustrated embodiment, the frame may be formed of rigid, durable beams such as 2 to 6 inch square steel tubes interconnected, as by welding or bolting, using a truss form, where necessary, for strength. The frame may be supported on wheels 24, 26, 28 for transport through the field or on roadways. Wheels 24 are positioned to support the center of the frame, while wheels 26 and 28 support the ends of the tool support arms and the trailing unit, respectively.

Wheels 24 and 28 can be fixed to rotate in planes parallel to the long axis of the frame. Wheels 26 may be caster style wheels to support movement of the arms, as will be appreciated. Placing wheels 24 under the heavy center unit and without the ability to pivot about a vertical axis may act against side drift problems during use of the harrow. It is to be understood that some of the wheels can be removed and/or moved about to correspond with the means of towing. For example, the hitch can be shortened or the frame can be connected closely to the towing vehicle such that wheels 24 may no longer be needed.

[0029] Each of the right tool support arm 16 and the left tool support arm 18 may be elongate and have an end 16a, 18a secured to the center unit and an outboard end 16b, 18b. The tool support arms may each include brackets 30, 32 for engaging harrow ground working tool 33 (Figures 3A and 3B) at its ends. When in use, the tool support arms are extended out from the center unit as shown in Figure 2 with a relative angle therebetween. The tool support arms 16, 18 can be extended outwardly at various angles to select the degree to which the ground working tools engage the ground. In the in-use condition, the harrow can be quite wide such as for example 40 or 50 feet from

end 16b to end 18b. In one embodiment, the harrow can be further widened by insertion of additional beam lengths, as by use of a flanged bolt plate, into the tool support arms. Thus, it is desirable that the tool support arms be foldable (Figure 3C) to reduce the width of the tool for transport and storage. Therefore, while the tool support arms can be locked into the in-use condition, the tool support arms can each act as levers about the center unit. In particular, each tool support arm may include a fulcrum 34 adjacent its secured end where it is fixed on the center unit and permitted to pivot in a plane parallel to the ground surface on which the frame is placed (i.e. horizontal). The fulcrum can be formed in any way such as by insertion of a pin through an opening on the support arm. The pin may be secured in various ways on the center units such as, for example, between rigid members such as plates 37a (Figures 5) or bars 37b (Figures 4) on the center unit.

[0030] The drive system may act adjacent the secured ends of the tool support arms to pivot the left tool support arm and the right tool support arm about their fulcrums to move them between a folded condition and an open in-use position. The drive system may be configured to permit the

support arms to pivot in a substantially simultaneous way. The drive system may be connected to each of the tool support arms between their fulcrums 34 and their secured ends 16a, 18a. Drive system 22 is, in the illustrated embodiment, a hydraulic cylinder 36 mounted at a fixed end 38 to the center unit and with a rod 40 pivotally connected by a pin 42 into slots 44, 46 in the tool support arms 16, 18, respectively. Using one cylinder, the arms can be pivoted at the same rate without the need to synchronize with other drive systems. The tool support arms may be formed at their secured ends to permit overlap such that they can each be in engagement with the pin, but each able to pivot freely without interference therebetween. In particular, secured ends 16a, 18a of the tool support arms may be formed as plates or c-shaped members to permit alignment of slots 44, 46 so that pin 42 can be passed therethough. Extension or retraction of rod 40 can drive, by engagement of pin 42 in slots 44, 46, the tool support arms about their fulcrums to pivot in the horizontal plane. Pin 42 may be restrained to move in an upper and a lower aligned guide rails 48, 50 to urge the pin and rod to move along a selected axis and to seek to prevent the pin from adversely twisting out of a substan-

tially vertical plane. The limits of extension and folding of the tool support arms can be established by selecting the stroke length of the rod, with respect to the position of the fulcrums or by placement of stops against which the tool support arms or rod can abut.

[0031] As will be appreciated, the drive system can include drive sources other than a hydraulic cylinder, such as, for example, a screwdrive, without changing its operation. The drive system may include a locking valve for hydraulic cylinder 36 that permits the rod to be locked once in a selected position. The locking valve is selected to withstand the pressures, such as for example 500 to 1,500 psi, necessary to hold the tool support arms in an extended position while the harrow is being used. Thus, if desired, no support beams or tensioning chains need be connected between the hitch, center unit or trailing unit and the tool support arms to maintain the arms in an extended in-use position.

[0032] As noted previously, the tool support arms may each include brackets 30, 32 for engaging harrow ground working tool 33 (Figures 3A and 3B) at its ends. The brackets may be formed to cantilever the ground working tool behind the support arm on which it is mounted. This leaves

room for wheels 26 to be positioned more directly under the support arms, if desired, thereby reducing twisting stresses on the arm. To facilitate transport of the harrow as shown in Figure 7, brackets 32 may be pivotally connected at 51 to their support arms and a hydraulic lift 52 may be provided between each support arm and bracket so that the bracket can be lifted to thereby lift the connected ground working tool upwardly out of contact with the ground. A hydraulic lift (not shown) may also be provided on brackets 30. However, sufficient ground clearance can sometimes be achieved by lifting only one end of the ground working tool. Thus, one or the other of hydraulic lifts can be omitted, as desired.

[0033] The harrow frame may often include a trailing unit 20. The trailing unit supports tail ground working tool 27, which in use may be operated to work the swath between ground working tools 33. It will be appreciated that while tool support arms 16, 18 can be folded back together to a certain degree, such folding may be limited by abutment therebetween of the trailing unit. Thus, in one embodiment, trailing unit 20 may be connected to center unit 14 by a pivotal connection 53 with a hydraulic lift 54 and by actuation of the lift, trailing unit 20 may be pivoted up-

wardly about connection 53. This raises the outboard end of the trailing unit out of the way so that support arms 16, 18 can be folded in below the trailing unit, as shown in Figure 3C. In the illustrated embodiment, which includes a lift for the trailing unit, fulcrums selected to be less than 8 feet apart, hydraulic lifts 52 for lifting ground working tools 33 and a drive system 22 between the hitch and the fulcrums, the harrow frame can be folded to a width, W, of less than 8.5 feet or in one embodiment, less than 8 feet. This meets most transport regulations allowing transport on roadways without a permit.

[0034] In one embodiment, a safety lock system may be provided wherein the system prevents the support arms from being folded back toward the trailing unit beyond a selected angle unless the trailing unit has been lifted out of the way. This system can be embodied in various ways. In the illustrated embodiment, the system may sense the position of rod 40 of drive system 22. In particular, rod 40 may have attached thereto an extension 60, which rides along with the rod. Extension 60 may have an end 60a that rides in a slot 70. When support arms 16, 18 are being folded out toward hitch, end 60a may ride in slot 70 toward the tail harrow and when the support arms are being folded in to-

ward the tail harrow, the extension end may be retracted toward the cylinder. At a selected position along the slot, which corresponds to the stroke length of rod 40 when support arms 16, 18 are moving outwardly and at about 45°, a diverting wall in slot 70 may be configured to force extension 60 into engagement with a slider 72 disposed in the slot. Referring to Figure 5B, slider 72 may be slidably mounted in an end of slot 70 and may include an opening 71 sized to engage extension end 60a. Opening 71 may pass through the slider. Extension 60 may drop into the opening from an inner side, while a control bar may extend into the opening in slider 72 from the opposite side. When extension 60 is forced into the opening, it may push the control bar out of the opening. When control bar is pushed out, this may cause the hydraulic system to be locked such that support arms 16, 18 cannot be folded back beyond 45° until the system is unlocked. The system can be unlocked by raising tail harrow. When tail harrow is raised, the rod 40 can be retracted such that arms are folding back past about 45°. In so doing, slot 70 diverts extension end 60a to pull out of slider 72 and the control bar can drop back into the opening in slider to reset the locking system. In addition, the control bar may

maintain the slider in position along slot 70 so that extension can drop into the opening, when rod 40 drives it out. Extension 60 may also be useful in other harrow control systems, as will be described in more detail hereinbelow.

[0035] The above-noted control system may also be useful for controlling the operation of hydraulic lift 52 and the hydraulic lift on bracket 30. In particular, the control system can prevent the ground working tools 33 from being lifted while the support arms are between 25°and 45°. In addition, the control system may prevent the arms from being folded toward tail harrow 27 until the ground working portions 33 are lifted.

[0036] Another safety mechanism can be provided wherein the trailing unit may include a clamp 65 that can be secured over the arms when they are folded beneath the trailing unit. Such a clamp may assist in holding the frame in a folded configuration and acts against inadvertent unfolding, for example, during transport.

[0037] While it is useful to be able to move the tool support arms between a folded configuration and an in-use position, it is also desirable to adjust the position of the arms when in the in-use position to adjust their angle of aggression.

It is useful to have this functionality "on-the-fly" when the harrow is moving, in use or during towing. As an example, when the harrow is moving, usual speeds are at least about 3 miles/hour, with a common speed being between about 3 to 15 and the angle of aggression may be adjusted at these speeds. In some more common applications, the angle of aggression may be adjusted at speeds of between about 6 to 10 miles/hour.

[0038] The angle of aggression is referenced to a horizontal axis, x, orthogonal to the long axis of the harrow frame through the hitch. Generally, the most useful angles of aggression range between 25° and 45°. For example, the tool support arms can be used in a 45° angle of aggression as shown in Figure 3A or in a 25° angle of aggression as shown in Figure 3B or at any selected angle between 25°and 45°. The greater the angle of aggression, the greater the tilling action achievable by the ground working tool. The angle of aggression of the harrow frame can be adjusted by the drive system alone. This permits the angle of aggression to be adjusted from the safety of the operator's compartment of the vehicle without manually adjusting anything on the frame and can be done while the harrow is being moved or used. The drive system may move

the support arms substantially simultaneously at about the same rate and, therefore, may be used while the harrow is in motion without destabilizing it by unbalancing the forces between the support arms.

[0039] In one embodiment, the angle of aggression of the tail harrow can also be adjusted. In the illustrated embodiment, the angle of aggression of the tail ground working tool 27 can be adjusted between 25° and 45° corresponding to the angle of the ground working tools 33 on the support arms. In particular, slider 72, which was described hereinabove, may be connected to drivingly engage a linkage 68 that selects the angle of aggression of ground working tool 27 on the trailing unit. Linkage 68 may be pivotally connected at a plurality of positions to translate sliding movement of slider 72 to rotational movement of a shaft 74 journalled on the trailing unit. Rotational movement of shaft may cause a bracket 73 supporting ground working tool 27 to rotate, as indicated by arrow A.

[0040] Once extension 60 engages into slider 72, they may move together in response to movements of rod 40 until the extension is retracted by the rod to disengage from the slider. Linkage 68 may be selected such that when arms 16, 18 are at any particular angle of aggression, bracket

73 may be at a substantially similar angle of aggression.

[0041] When using a harrow on an uneven ground surface it is sometimes difficult to evenly work the soil. In one embodiment, of the present invention, various means may be provided to permit adjustment manually or automatically of the frame components and ground working tools relative to the ground. These various means can be used alone or in combination on any particular harrow.

[0042] In one embodiment, hydraulic lift 54 may be positioned to lift trailing unit 20 but when not in the lift position, may not inhibit pivoting of the trailing unit relative to center unit 14 about pivotal connections 53. Thus, the trailing unit, when in use, can pivot relative to center unit 14 to maintain ground working tool 27 in contact with the ground even when passing over undulations in the ground surface. To permit free pivoting around connection 53, hydraulic lift 54 can, for example, be selected normally to be retracted completely and disconnected from the trailing unit, as shown. Alternately, hydraulic lift can be connected to the trailing unit but may include an open hydraulic circuit that unlocks the hydraulic fluid flow when the lift is not acting to lift the trailing unit.

0043] In addition or alternately, the position of wheel 28 can be

adjusted to select the height at which trailing unit 20 is conveyed and, thereby, the depth to which ground working tool works the soil. In particular, wheel 28 may be mounted using an extendable support. An extendable support may include a shaft 75, which may be telescopically disposed within a tube 76. The degree to which shaft 75 extends into tube 76 may determined by a turnbuckle 77.

[0044] In another embodiment shown in Figure 6, the bracket 73a of the tail harrow may be formed to pivot or be at least in part adjustably fixed in a selected angle off horizontal. In particular, bracket 73a may include eyes for connection of a ground working tool and a pivotal connection 78 may be provided between bracket 73a and shaft 74a such that frame can pivot in a substantially vertical plane about the shaft. If it is desired to adjust the degree to which the frame can pivot, adjustable stops 80 can be mounted on shaft above bracket 73a. Stops 80 may be pivotally connected at 82 to shaft and rods 84 may be mounted to maintain the stops in a selected orientation relative to shaft, as determined by the lengths of rods 84. The lengths can be selected in various ways as by use of turnbuckles 86. Thus, in use, bracket 73a can pivot verti-

cally about connection 78 as limited by abutment against stops 80.

[0045] In another embodiment, the tool support arms may include hinges 87 permitting the outboard end of the arms to pivot in a substantially vertical plane. This may permit the outboard ends of arms 16, 18 to pivot to adapt to undulations in the ground surface. Hinges 87, however, may not adversely affect the folding or angular orientation of the arms since they act about another axis.

[0046] In another embodiment, brackets 30, 32 may be selected to permit the ends of each ground working tool 33 on arms 16 and 18 to flex independently. In particular, brackets 30, 32 may each have pivotal connections therein which may be formed to respond to the weight of the ground working tool to keep it in engagement with the ground. A bracket 32a useful in this embodiment is shown in Figure 7. Bracket 32a may be mounted to arm 16 at one end and at its other end may include a connector 89 for securing a ground working tool (not shown). Bracket 32a may include a pivotal connection 51 about which hydraulic drive 52 may operate to lift the bracket, as was described hereinbefore. Bracket 32a can pivot about connection 51 when driven by the hydraulic drive

and otherwise may be locked against pivoting at this connection. To provide for flex in the arm in response to undulations in the ground surface, another pivotal connection 92 may be provided between connection 51 and connector 89. Bracket 32a can flex in response to forces acting on the bracket below pivotal connection 92. Pivotal connection 92 may be selected to maintain tension in tool 33 by maintaining spacing between brackets 30, 32. If desired, bracket 30 can also be formed to have a pivotal connection therein.

[0047] Figure 7 illustrates another possible embodiment, wherein connector 89 may be positioned on a shaft 96 that is telescopically disposed in a tube 98. The extension of shaft 96 from tube 98 can be selected by use of a turnbuckle 100. This permits the ground working tool 33 to be placed under whatever tension is desirable for its functioning, but without extending shaft 96 laterally outwardly from the harrow frame anymore than is desirable to tension the ground working tool.

[0048] A control panel may be provided for control of the drive system and other hydraulic drives on the harrow frame. The control panel can be positioned for example in the driver compartment of the vehicle and can include con-

trols preselected to move the frame into various selected positions for example, "folded", "45°" and "25°". To simplify the harrow, there can be a central hydraulic fluid tank and lines leading from the tank to the various cylinders.

[0049] Referring to Figure 8A, there is shown another harrow frame 110 which may include a hitch 112, a center beam 114, a right tool support arm 116, a left tool support arm 118, a trailing unit 120, two expansion beams 121 for driving the tool support arms between a folded position and an open in-use position, a drive system 122 for driving the tool support arms between selected angles of aggression once the arms have been expanded by the expansion beams into the in-use position and a plurality of wheels 126, 128 for supporting the frame during transport.

[0050] Each of the right tool support arm 116 and the left tool support arm 118 may be elongate and may have an end 116a, 118a pivotally secured through pivots 129 to the center beam. Arms 116, 118 may also have outboard ends 116b, 118b, respectively. The tool support arms may each include brackets 130, 132 for engaging the ends of a harrow ground working tool (not shown). When in use, the tool support arms may be extended out from the center

unit as shown. However, the frame can be folded by use of folding beams 121 to drive arms 116, 118 around pivots 129 toward center beam 112. In particular, the folding beams may each be pivotally connected to their support arms and may each include a hinge 133 about which the beam can fold. The folding of beams 121 may be driven by cylinders 135. When the cylinders are retracted, the beams can fold to draw arms 116, 118 inwardly toward the center beam. When cylinders 135 are extended, the beams may be locked in an extended position to support the support arms in the working position.

[0051] When the tool support arms 116, 118 are extended out by the folding beams, the drive system 122 can be used to adjust the angle of aggression of the arms to select the degree to which the ground working tools engage the ground. In one embodiment, the beams may be selected to drive the arms from a folded condition to a 45°angle and the drive system may selected to drive the arms between 45° and 25°. Referring also to Figure 8B, folding beams 121 may each be connected at hinge 121a to a drive lever 137. Drive system 122 may drive the beams through levers 137 that pivot about fulcrums 134 to adjust the angle of aggression of arms 116, 118. The ful-

crums 134 may be secured on rigid beams 137a of the drive system frame.

[0052] Drive system 122, in the illustrated embodiment, may include a hydraulic cylinder 136 mounted to the drive system frame with a rod 140 pivotally connected by a pin 142 to levers 137. Using one cylinder, the levers and thereby the beams can be pivoted at the same rate without the need to synchronize. Extension or retraction of rod 140 may drive pin 142 to pivot levers 137 about their fulcrums in a horizontal plane. Pin 142 may be restrained to move in an upper and a lower aligned guide rails 148, 150 to urge the pin and rod move along a selected axis and to seek to prevent the pin from twisting substantially out of a vertical plane. The limits of extension of the tool support arms can be established by selecting the stroke length of the rod, with respect to the position of the fulcrums and the lengths of the expansion beams or by placement of stops against which the tool support arms or rod can abut.

[0053] In one embodiment, to reduce the folded width of the harrow as much as possible brackets 130, 132 may each be provided with hydraulic lifts to raise the height of the attached ground working portion above wheels 128 and

trailing unit 120 can be pivoted orthogonally to center beam 114 to permit support arms 116, 118 to fold in above center beam and between the trailing unit and the hitch.

[0054] As will be appreciated, the drive system can include drive sources other than a hydraulic cylinder such as, for example, a screw drive without changing its operation. The drive system may include a locking valve for hydraulic cylinder 136 that permits the rod to be locked once in a selected position. The locking valve may be selected to withstand the pressures, such as for example 1,500 psi, necessary to hold the tool support arms in an extended position while the harrow is being used.

[0055] It will be apparent that many other changes may be made to the illustrative embodiments, while falling within the scope of the invention.

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Claims

[c1] 1.A harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a hitch, a center unit, a right tool support arm being elongate and having a secured end and an outboard end, a left tool support arm being elongate and having a secured end and an outboard end, the left tool support arm and the right tool support arm each acting as levers each with a fulcrum adjacent their secured ends through which they engage the center unit, a drive system acting adjacent the secured ends of the tool support arms to pivot the left tool support arm and the right tool support arm about their fulcrums to move them between a first relative angle and a second relative angle and a lock to releasably lock the left tool support arm and the right tool support arm into the first relative angle and the second relative angle, the drive and the lock being controllable remotely such that the left tool support arm and the right tool support arm can be pivoted about their fulcrums while the harrow frame is being moved along a ground surface.

[c2] 2.The harrow frame of claim 1 wherein the left and right

tool support arms are locked and driven substantially exclusively through connections at their secured ends.

[c3] 3.The harrow frame of claim 2 wherein the connections are provided between the tool support arm secured ends and the tool support arm fulcrums.

[c4] 4.The harrow frame of claim 1 wherein the lock is selected to act without relying on the use of tension chains connected to the tool support arms between the fulcrum and the outboard end.

[c5] 5.The harrow frame of claim 1 wherein the drive system is selected to act without relying on the use of tension chains connected to the tool support arms between the fulcrum and the outboard end.

[c6] 6.The harrow frame of claim 1 wherein the first relative angle is a first selected angle of aggression and the second relative angle is a second selected angle of aggression.

[c7] 7.The harrow frame of claim 1 wherein the first relative angle is an open position for use and the second relative angle is a folded position.

[c8] 8.The harrow frame of claim 7 wherein in the folded position, the relative angle between the left tool support

arm and the right tool support arm is such that the width defined between the outer limits of the left tool support arm and the right tool support arm is less than 8.5 feet.

[c9] 9.The harrow frame of claim 1 wherein the drive system includes a hydraulic cylinder that may be connected at one drive point to both the left tool support arm and the right tool support arm such that any input drive of the drive system may be conveyed to the tool support arms substantially simultaneously.

[c10] 10.The harrow frame of claim 10 wherein the lock is incorporated into the drive system by use of a locking hydraulic cylinder.

[c11] 11.A harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a towing end, a center unit, a right tool support arm being elongate and having a secured end and an outboard end, a left tool support arm being elongate and having a secured end and an outboard end, the left tool support arm and the right tool support arm each acting as levers each with a fulcrum adjacent their secured ends through which they engage the center unit, a drive system acting adjacent the secured ends of the tool support arms to pivot the left tool support arm and the right tool support arm substantially simultaneously about their fulcrums to

move them between a folded condition and an open position for use and a lock to releasably lock the left tool support arm and the right tool support arm into the open position for use, the drive system, the lock and the fulcrums selected such that in the folded condition, the frame has a width of less than 8.5 feet.

[c12] 12.The harrow frame of claim 11 wherein the drive system includes a hydraulic cylinder that may be connected at one drive point to both the left tool support arm and the right tool support arm such that any input drive of the drive system may be conveyed to the tool support arms substantially simultaneously.

[c13] 13.The harrow frame of claim 12 wherein the lock is incorporated into the drive system by use of a locking hydraulic cylinder.

[c14] 14.The harrow frame of claim 11 wherein the drive system is positioned such that it is substantially outside of the area between the folded tool support arms.

[c15] 15.The harrow frame of claim 11 wherein the drive system is positioned between the towing end and the center unit and the tool support arms fold away from the towing end behind the center unit.

[c16] 16.The harrow frame of claim 11 wherein the lock acts

adjacent the secured end to lock the left tool support arm and the right tool support arm into the open position for use.

[c17] 17.The harrow frame of claim 11 further comprising a wheel positioned to support the center unit, the wheel fixed substantially against pivoting about a vertical axis.

[c18] 18.The harrow frame of claim 11 further comprising a trailing unit for supporting a tail harrow ground working portion, the trailing unit having an outboard end and a secured end.

[c19] 19.The harrow frame of claim 18 further comprising a lift mechanism to raise the outboard end of the trailing unit upwardly during a folding operation to permit the left tool support arm and the right tool support arm to be folded under the trailing unit.

[c20] 20.The harrow frame of claim 19 further comprising a safety lock selected to prevent the left and right tool support arms from being moved into the folded configuration without the trailing unit first being raised upwardly.

c21] 21.The harrow frame of claim 19 further comprising a safety lock selected to lock the right tool support arm and the left tool support arm together in the folded con-

figuration by setting the trailing unit down on the tool support arms when they are folded under the trailing unit.

[c22] 22.A harrow frame for supporting a harrow ground working tool, the harrow frame comprising: a towing end, a center unit, a right tool support arm being elongate and having a secured end and an outboard end, a left tool support arm being elongate and having a secured end and an outboard end, the left tool support arm and the right tool support arm each including a first bracket and a second bracket spaced apart on the tool support arm for engaging the ends of a ground working tool to be mounted on the frame, the first bracket including an end connected to the tool support arm, a connector end for engaging the ground working portion and a pivotal connection between the tool support arm and the connector end selected to permit the connector end to pivot relative to the end secured to the tool support arm and independently of the second bracket.

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HARROW FRAME AND HARROW FORMED THEREWITH

Abstract

A harrow frame may be operable to permit pivoting of its ground working tool support arms between a first relative angle and a second relative angle. Pivoting may be achieved through a drive system and a lock controllable remotely such that the tool support arms can be pivoted about their fulcrums "on-the-fly" while the harrow frame is being moved along a ground surface. A harrow frame may also be folded to have a width less than 8.5 feet to facilitate transport.

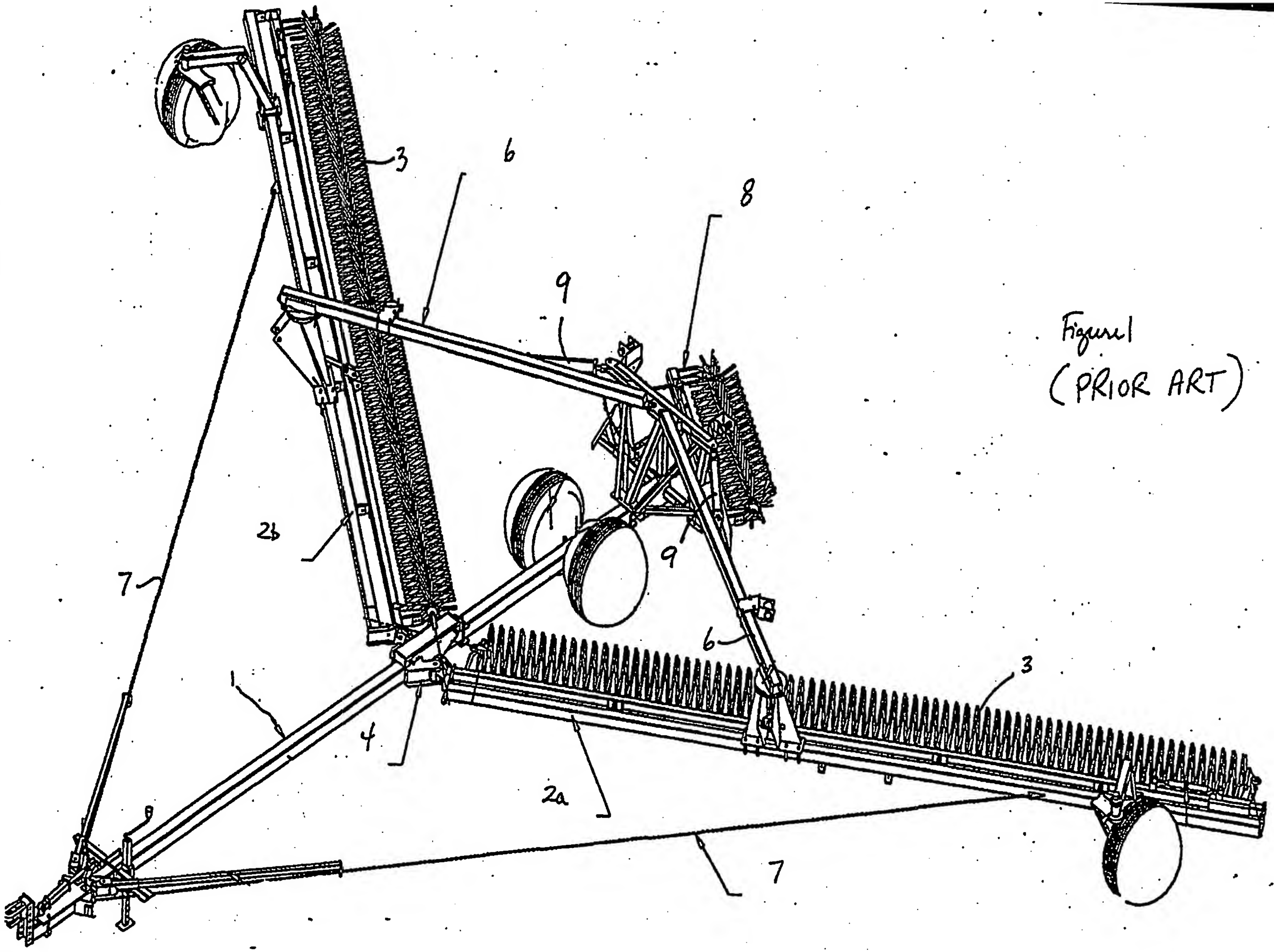


Figure 1
(PRIOR ART)

Figure 2

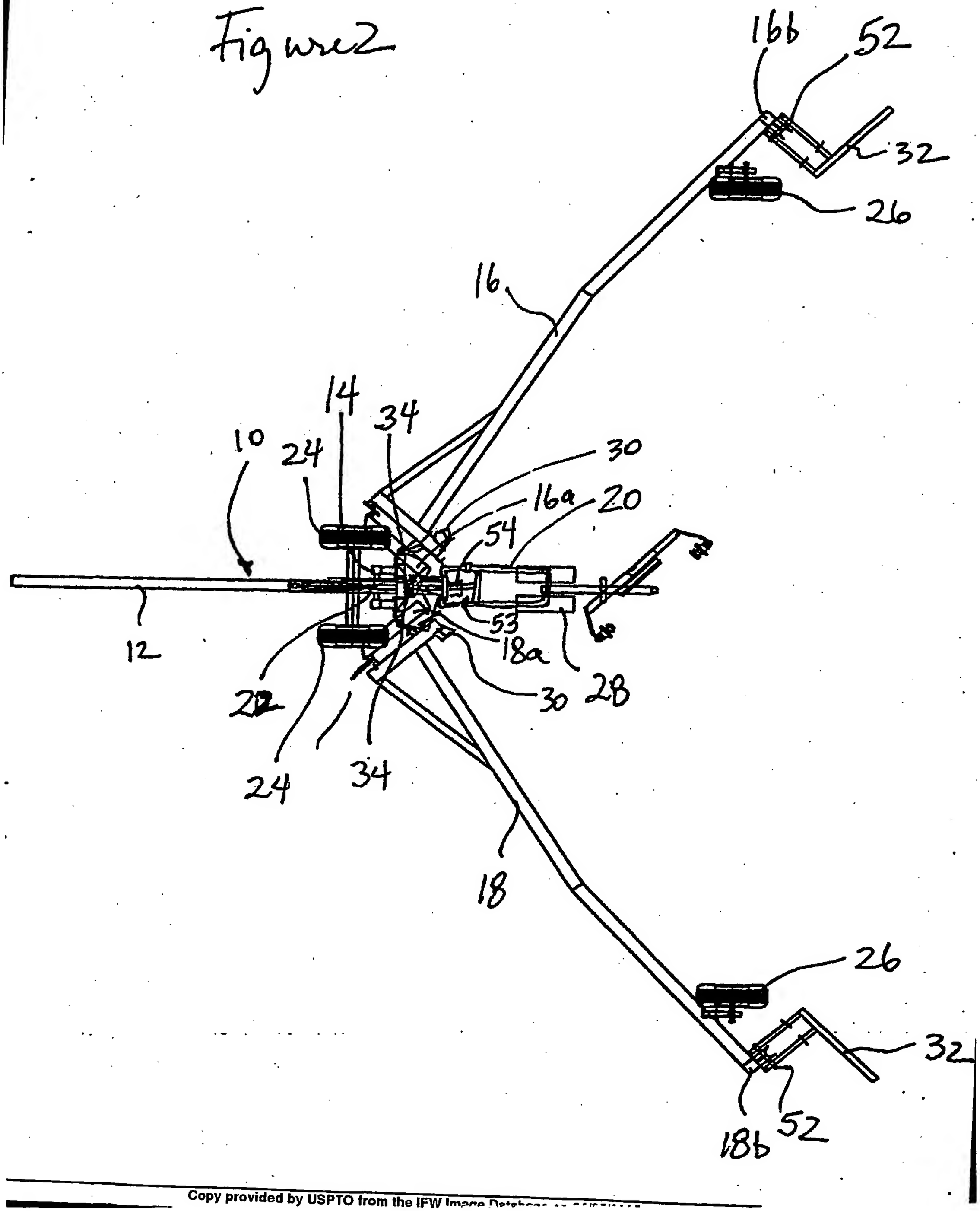


Figure 3A

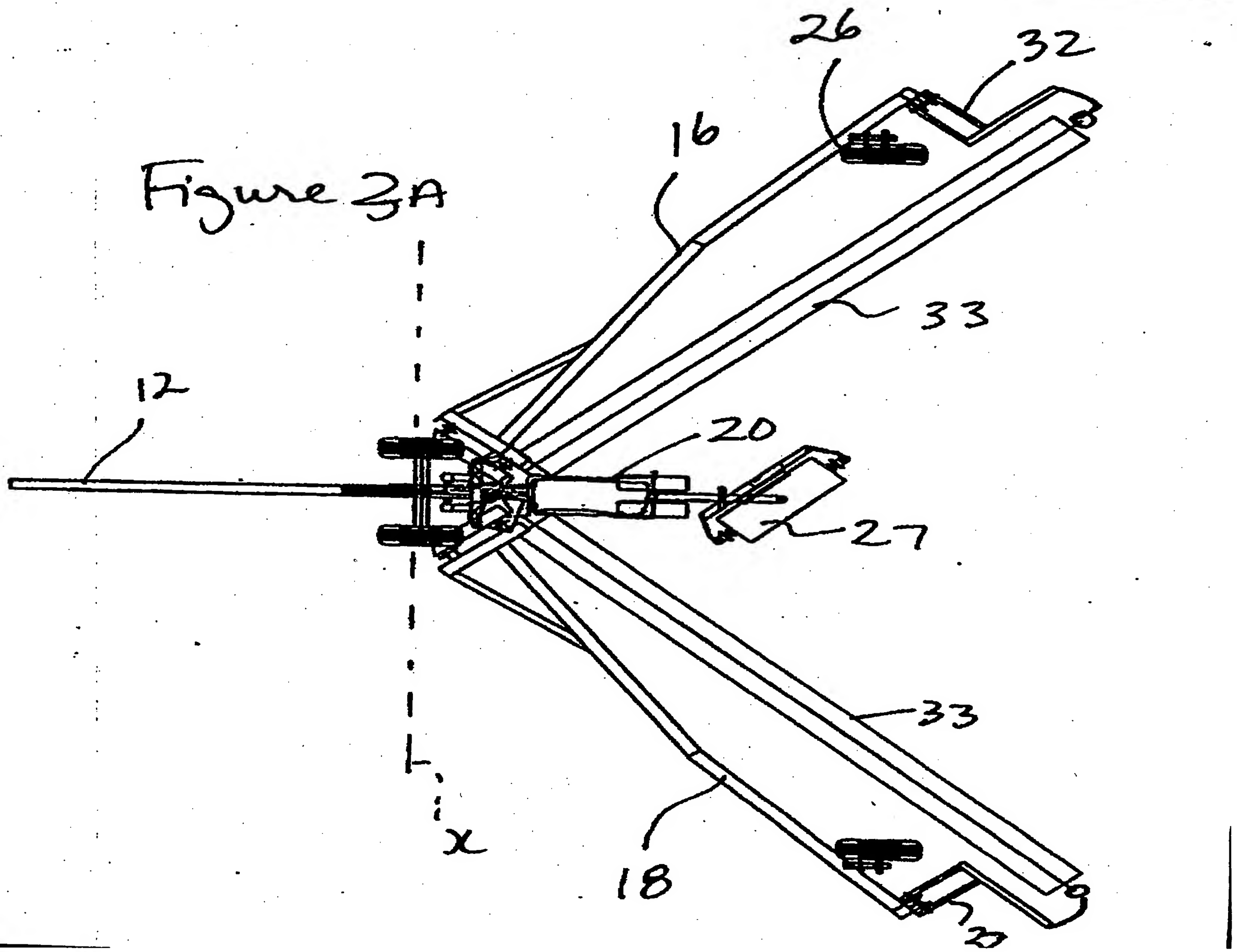
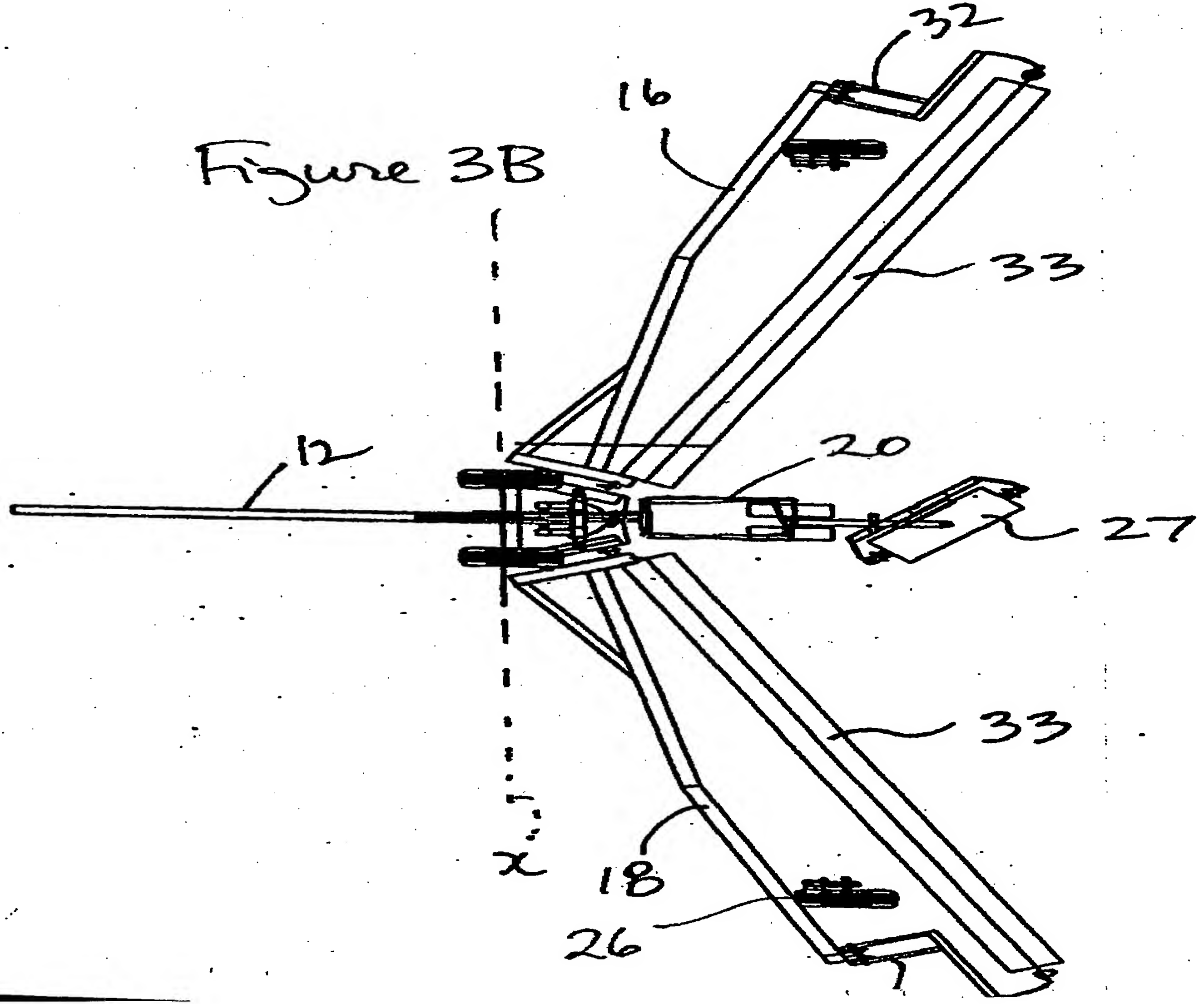


Figure 3B



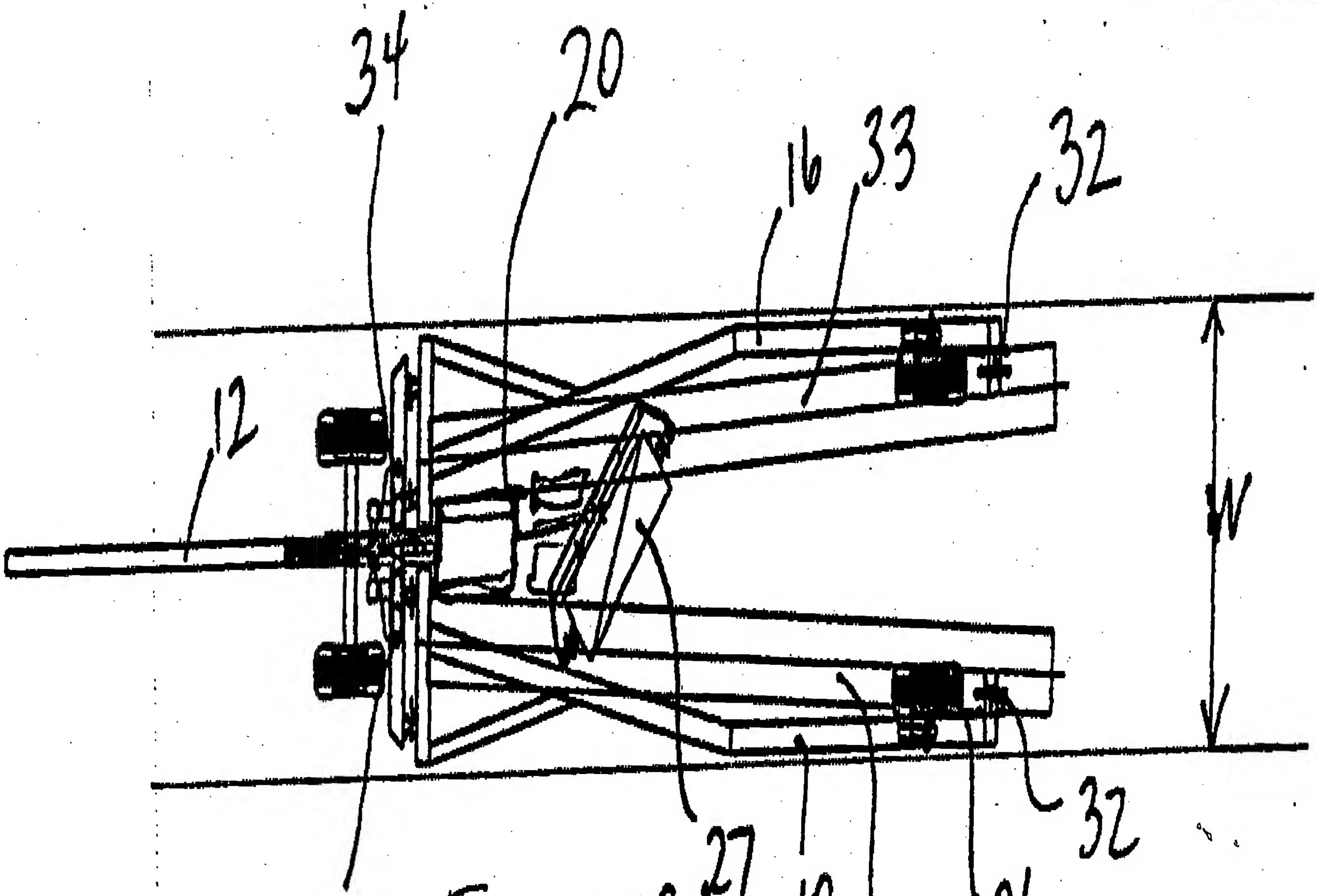


Figure 2C

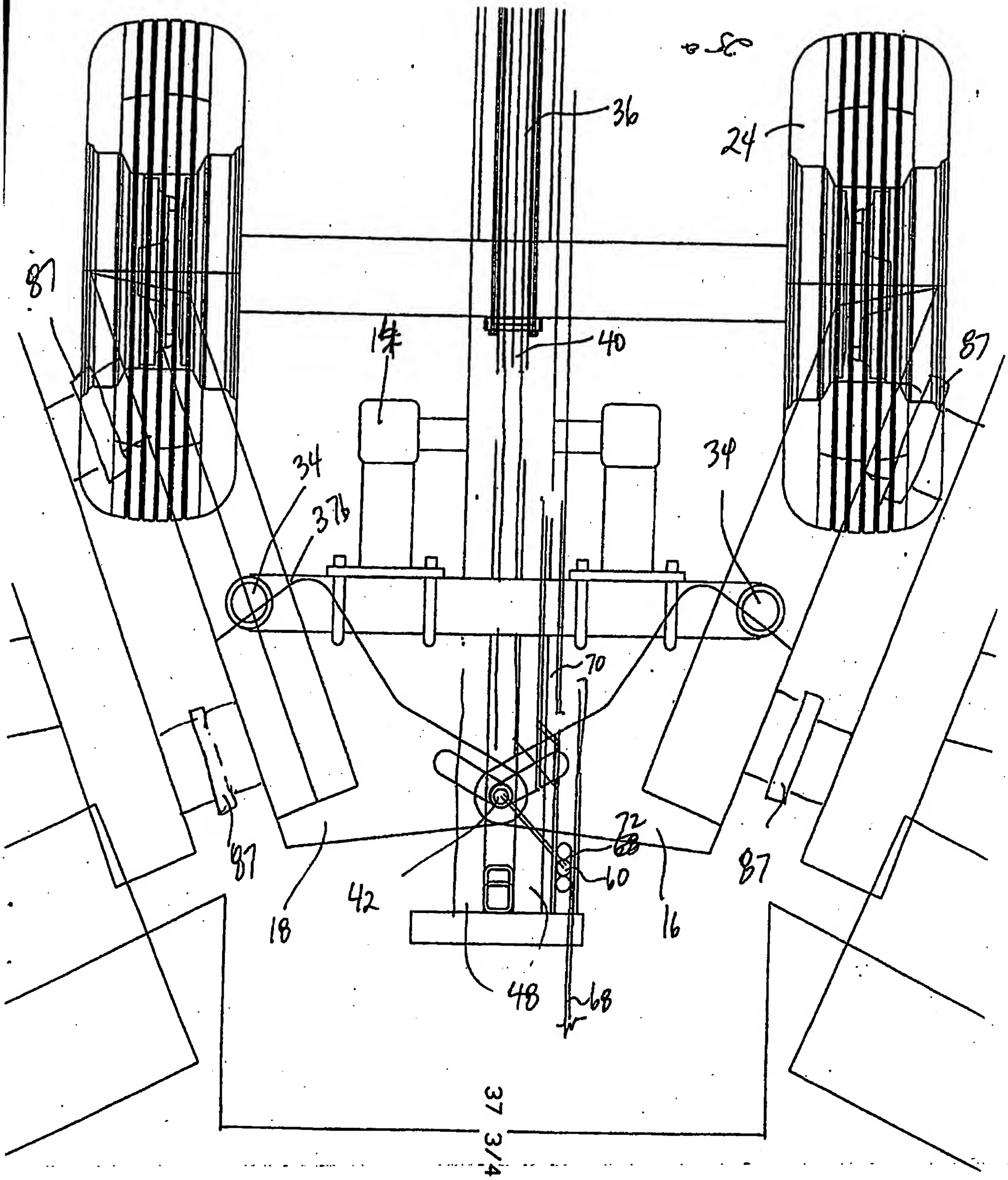


Figure 4A

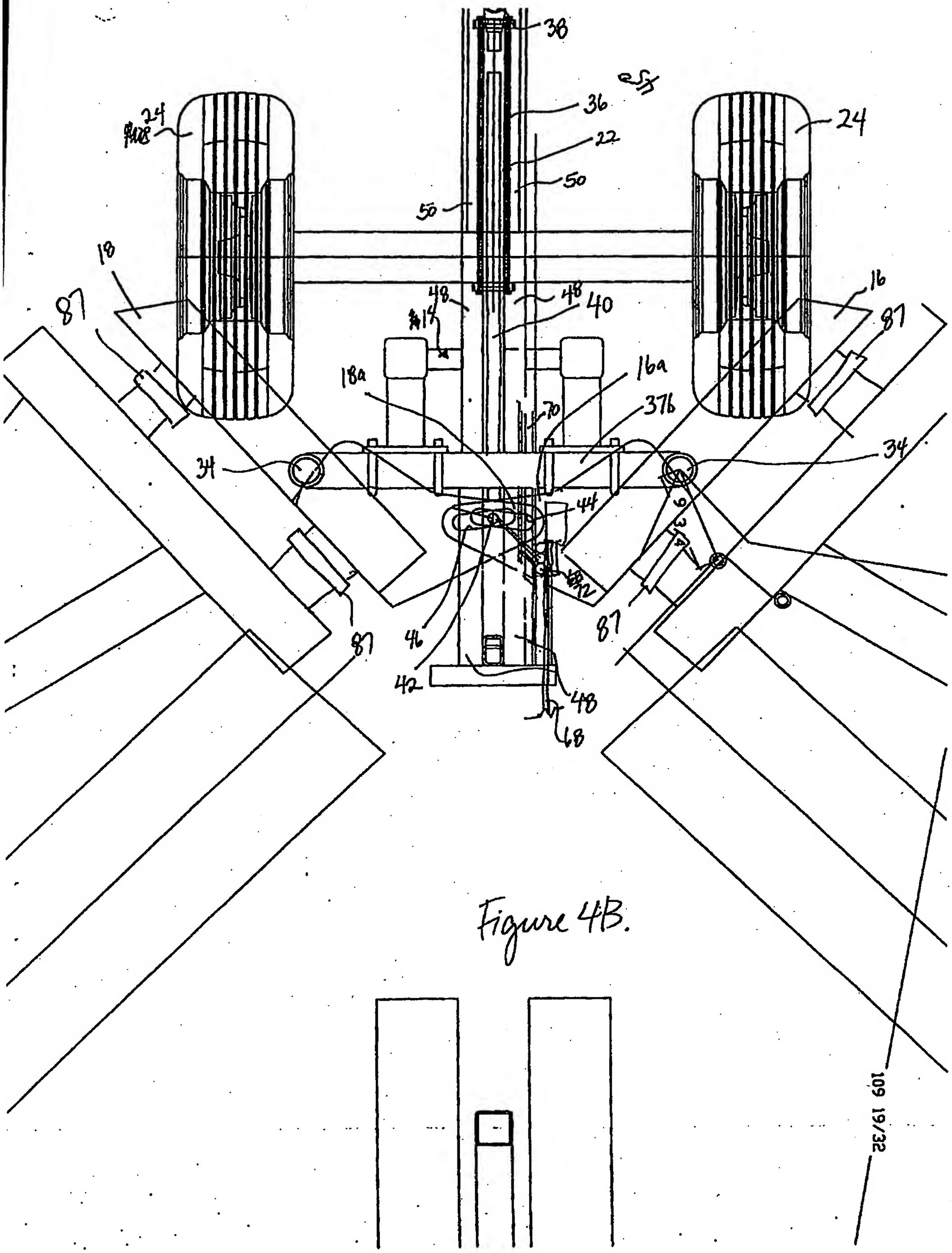
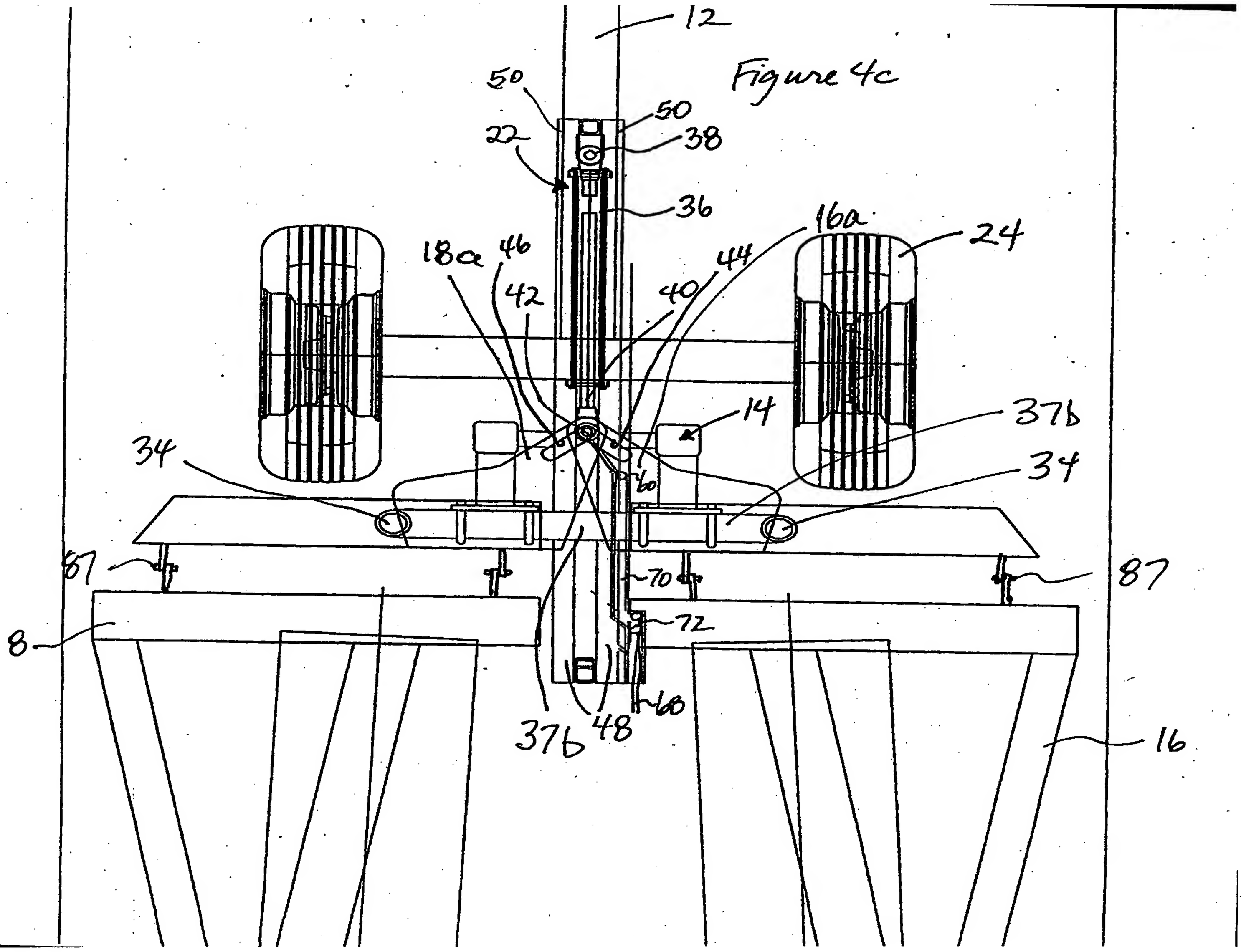


Figure 4B.

Figure 4c



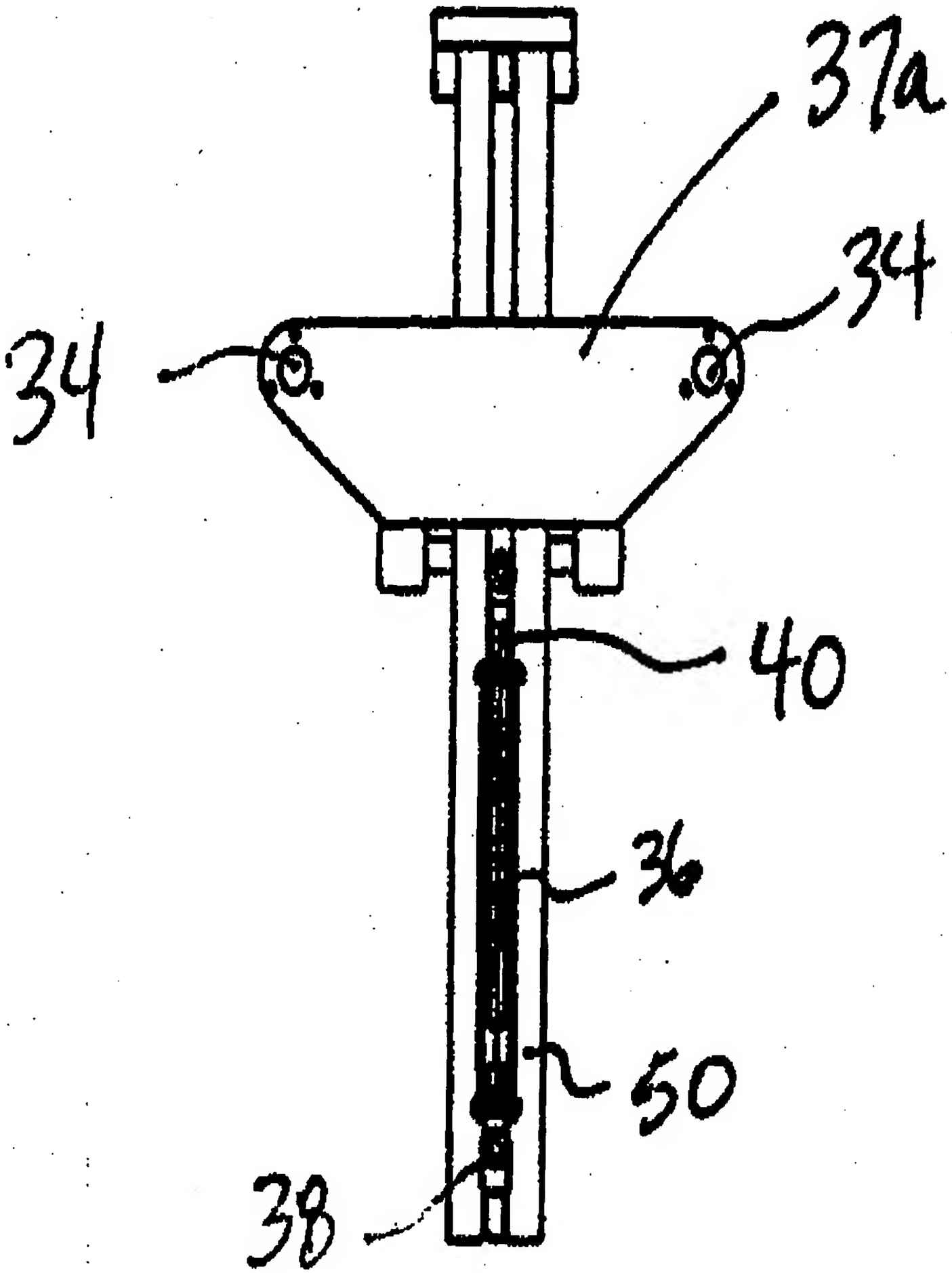
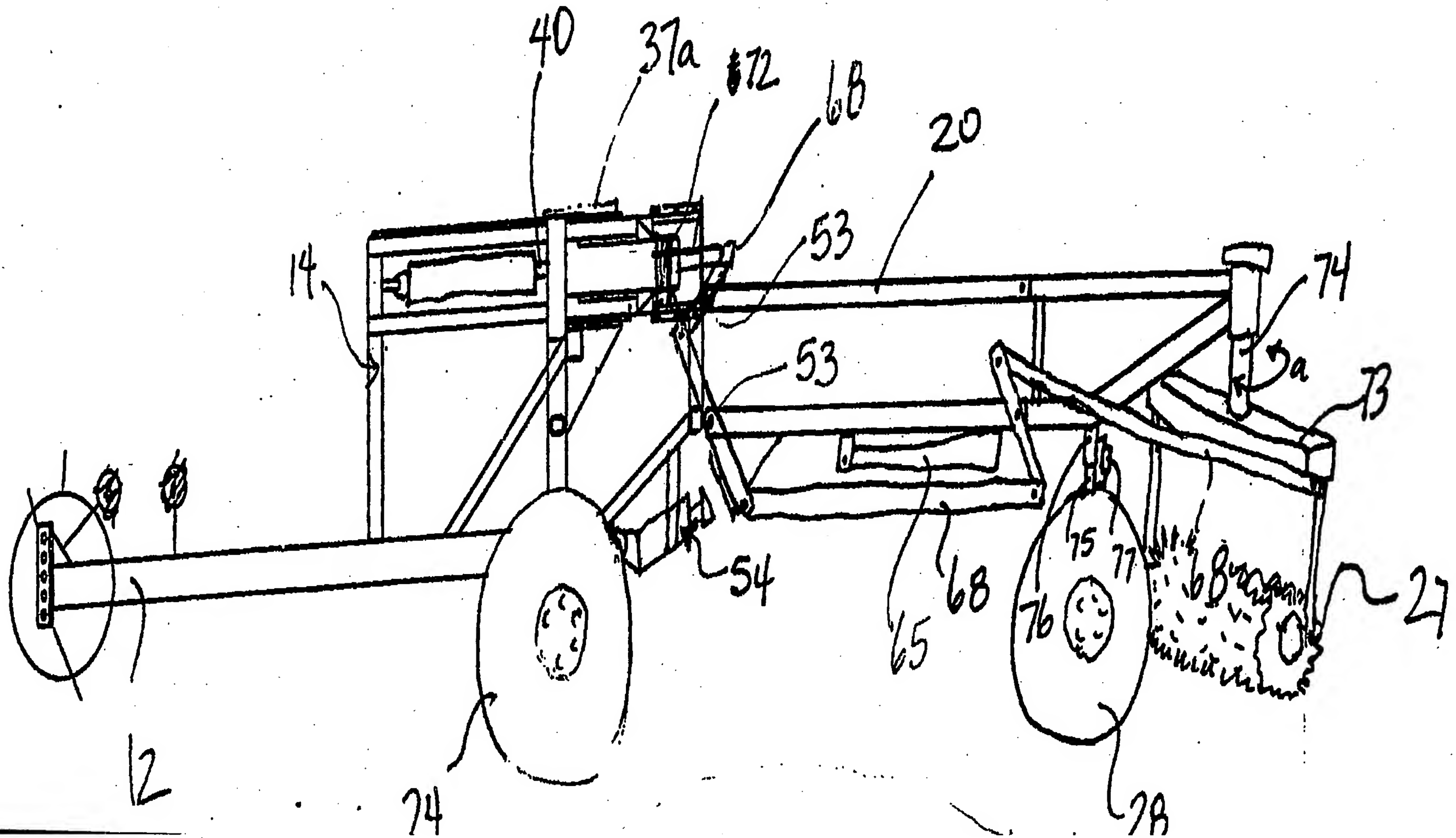


Figure 5BA

Figure 5B



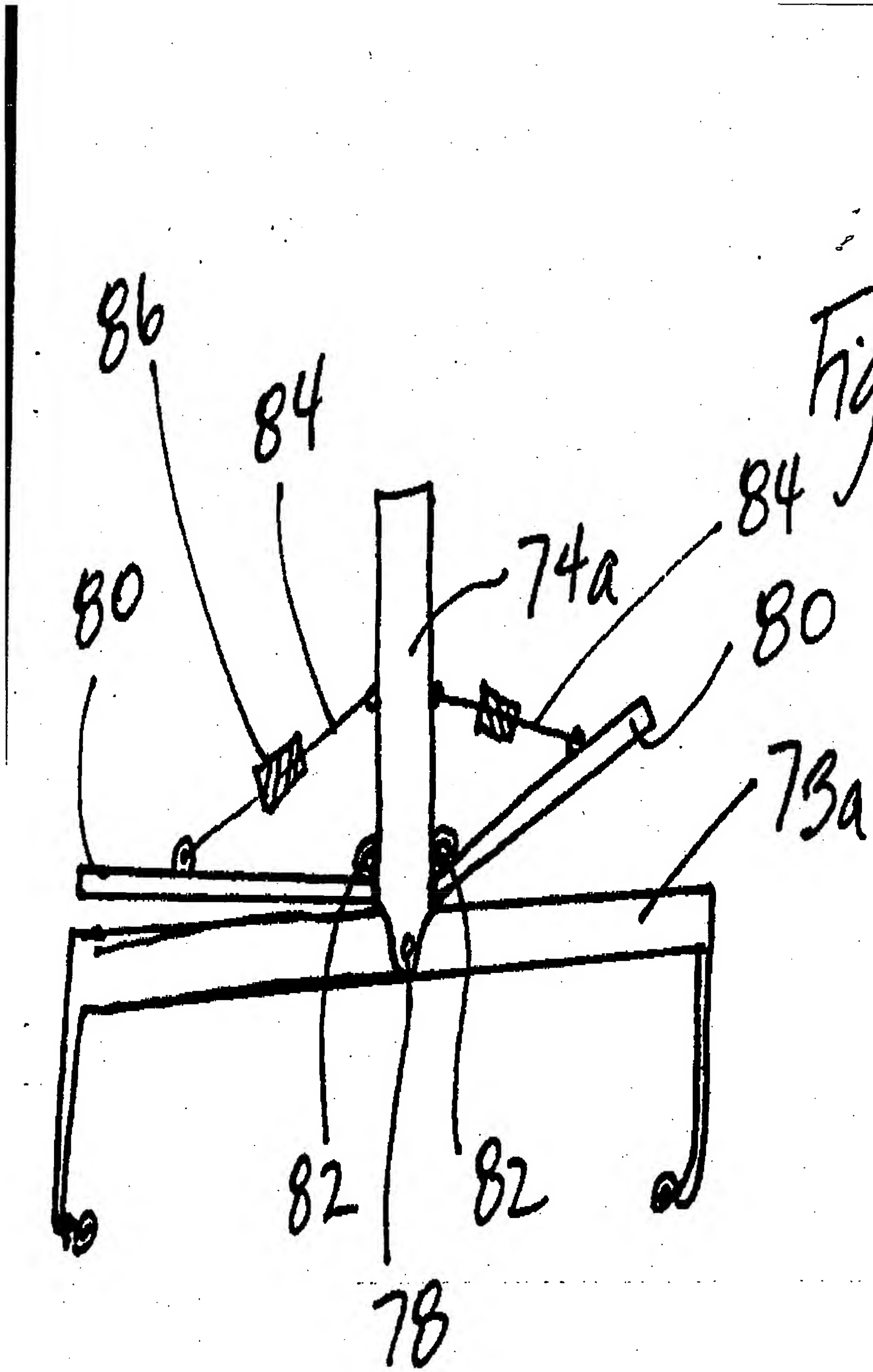
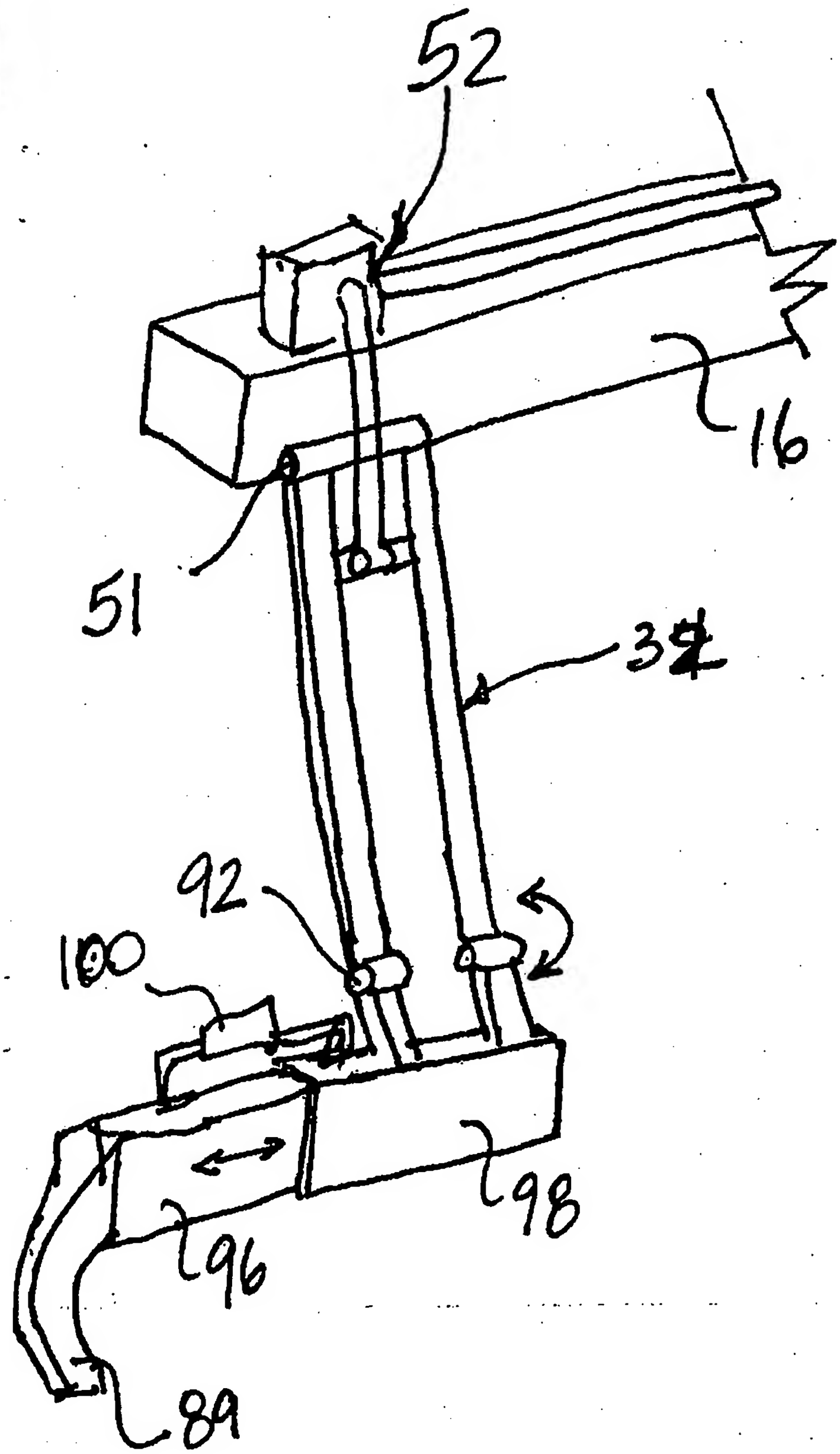


Figure 6

Figure 7



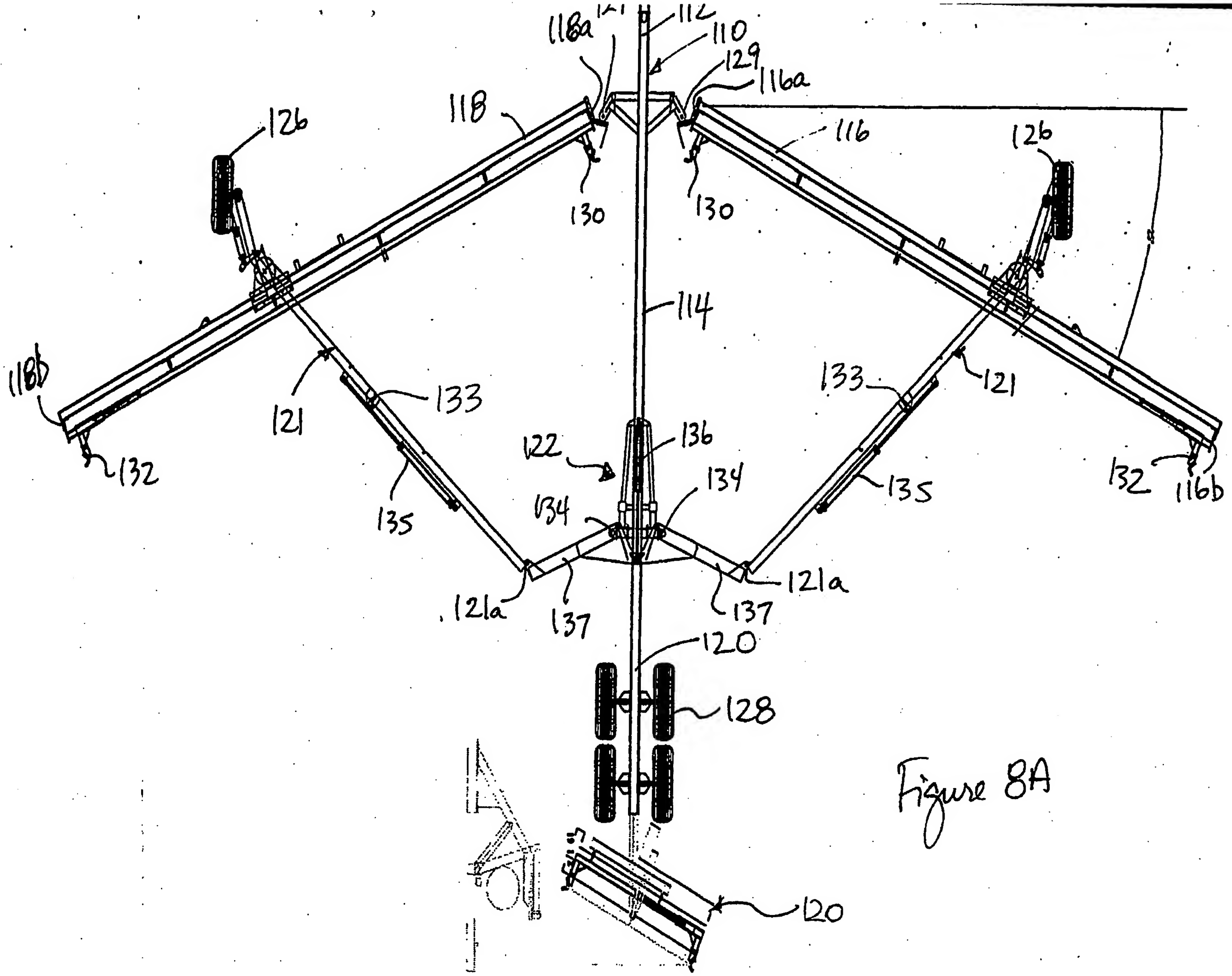


Figure 8A

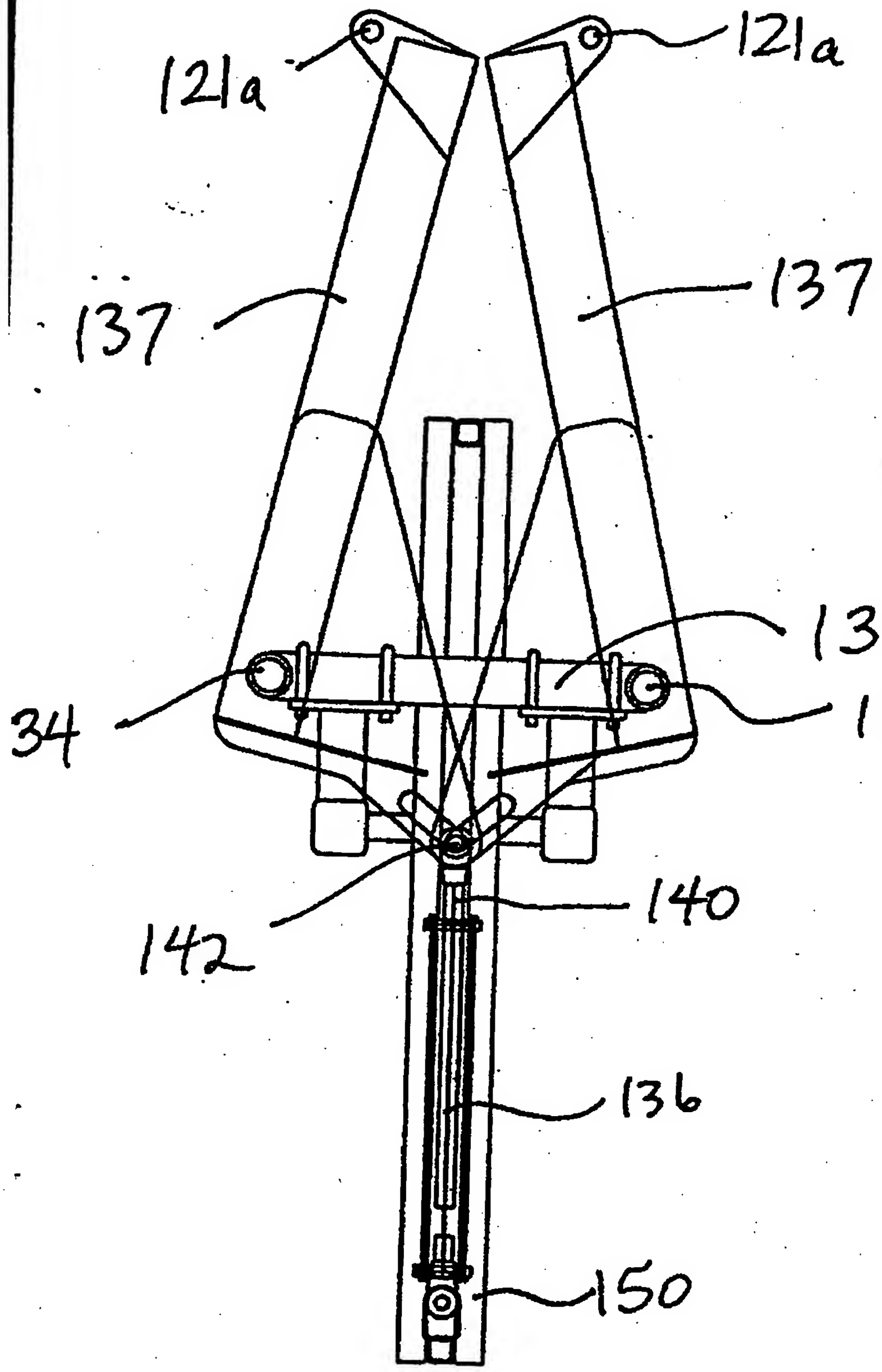


Figure 8B

TOP VIEW @ 45

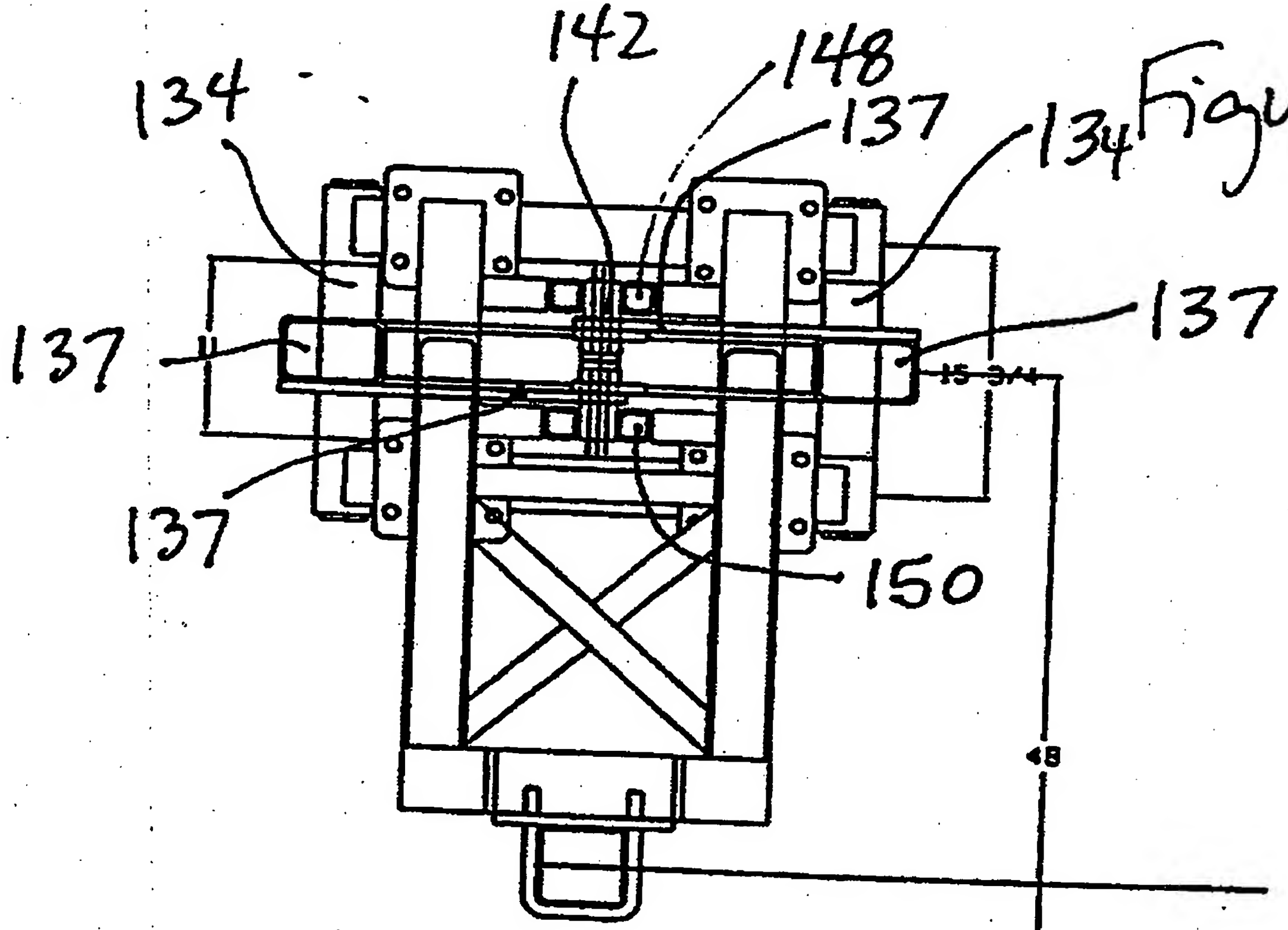
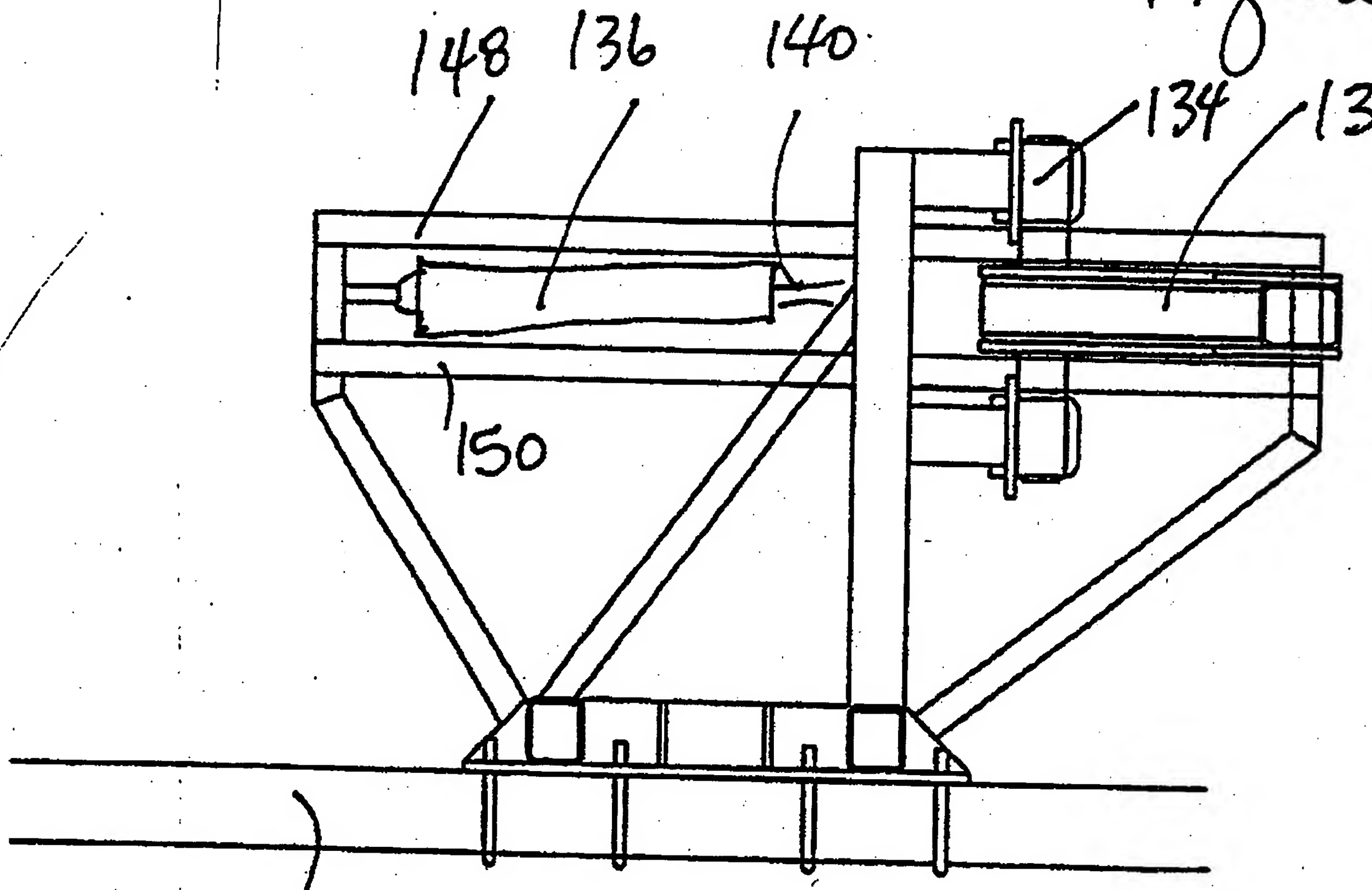


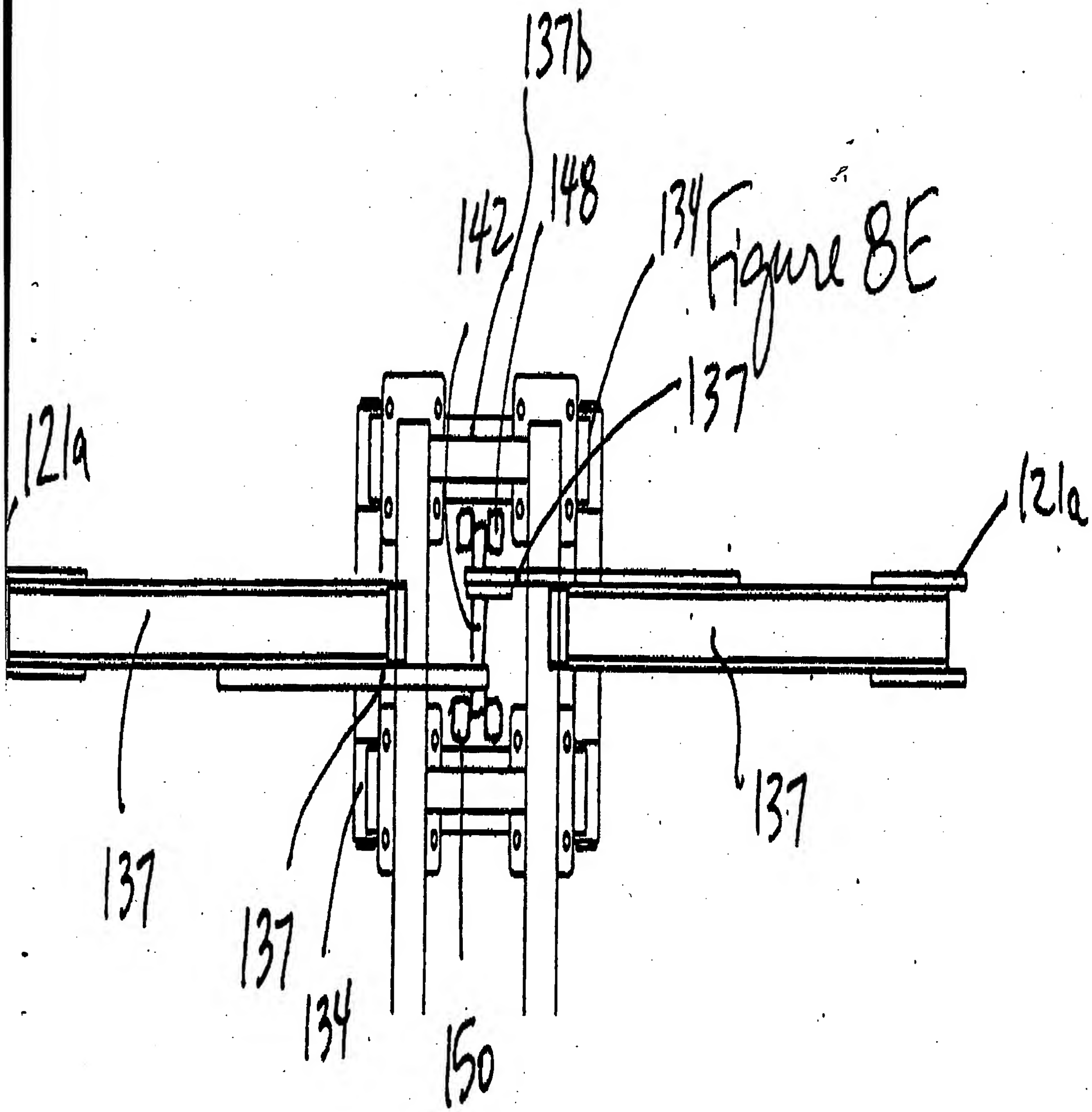
Figure 8C

FRONT VIEW @ 45

Figure 8D



SIDE VIEW @ 25



FRONT VIEW @ 25

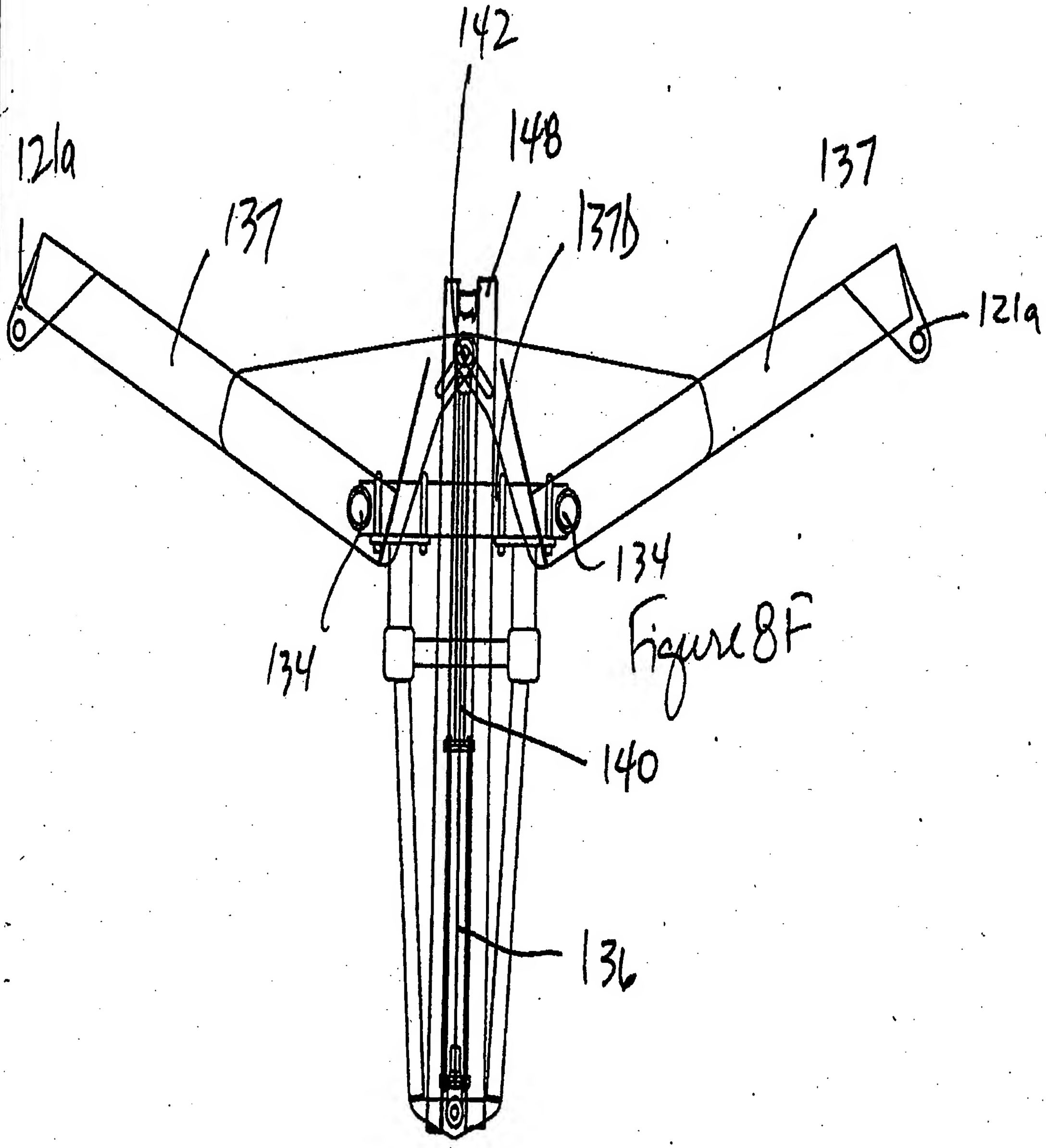


Figure 8F

TOP VIEW @ 25